



Wind Atlas in Northern European Seas: the EU-Norsewind project

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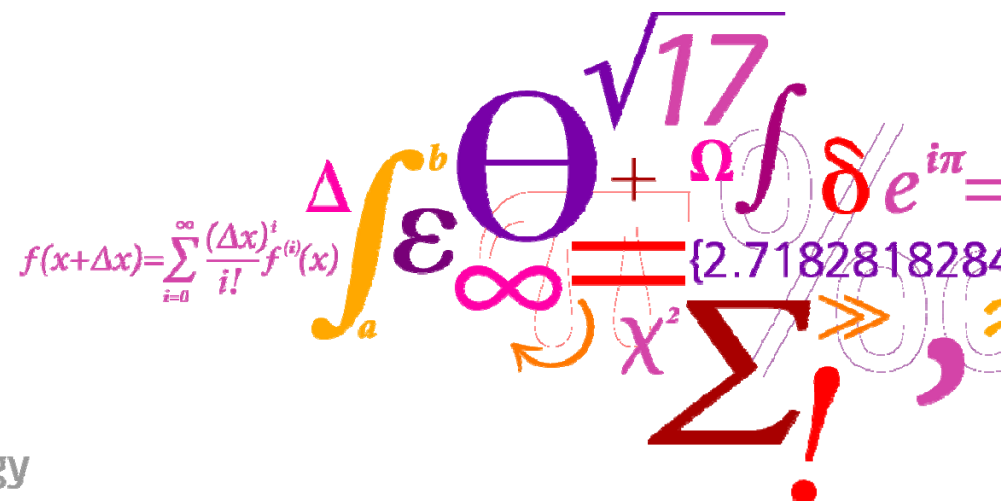
Wind Atlas in Northern European Seas: the EU-Norsewind project

C. Hasager, A. Peña, M. Badger, J. Badger, A. Hahmann, T. Mikkelsen, S.-E. Gryning, M. Courtney



Risø DTU

National Laboratory for Sustainable Energy



Norsewind



Norsewind: Northern Seas Wind Index Database

2008 to 2012 (4 years)

FP7 EU TREN 3.9 mio Euro

WP1: Lidar, satellite and met-data

WP2: Database

WP3: Shear and flow

WP4: Wind atlas

www.norsewind.eu



EU-Norsewind

Aim

- Aim is to produce a wind atlas for the Northern European Seas including the Baltic, Irish and North Seas.

Method

- Ground-based using 15 lidars and some met-masts.
- Satellite-based wind mapping.
- Atmospheric modeling.
- Testning for location offshore Portugal.

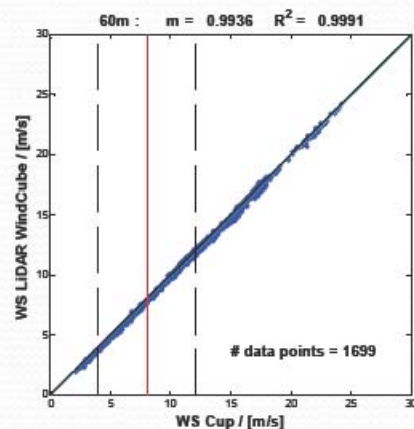
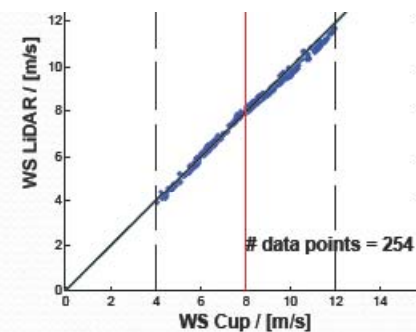
160 m tall mast

Lidar testing at Risø DTU

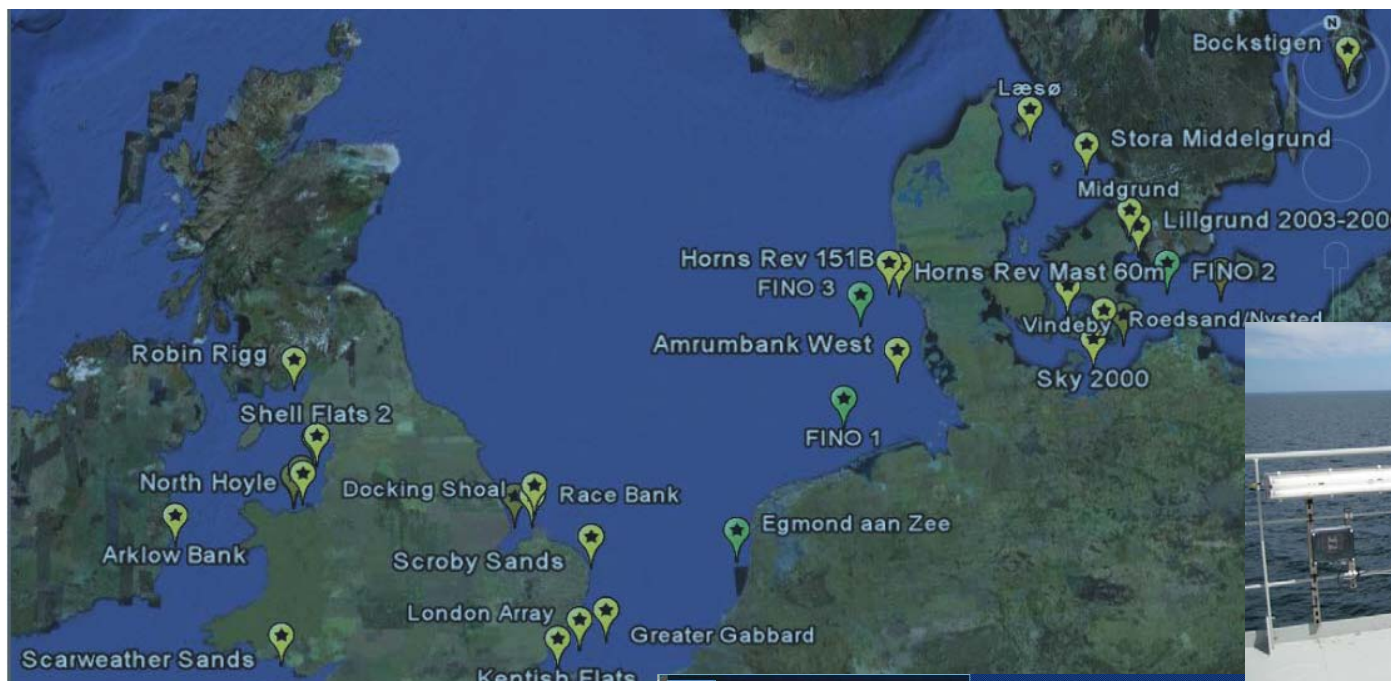


EERA – Wind Conditions Workshop, 26-28 January 2011

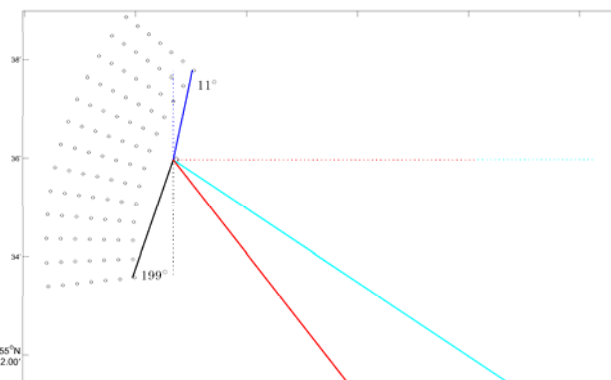
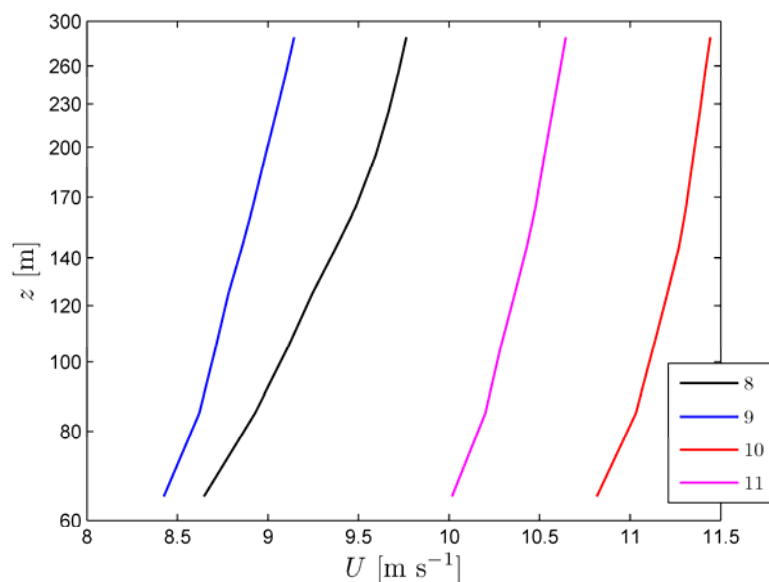
Lidars



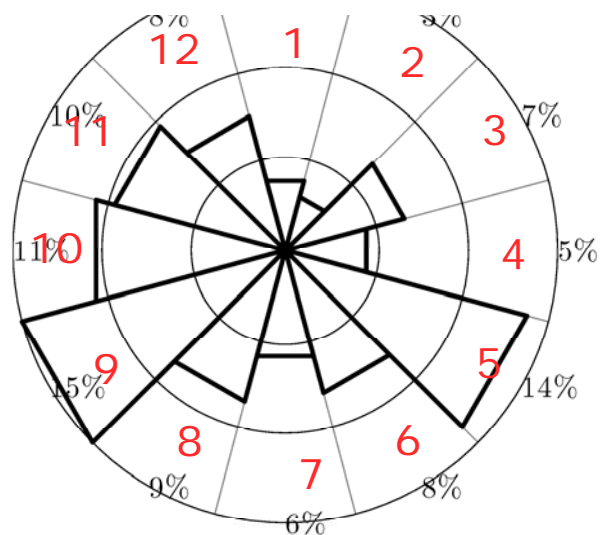
Oldbaum Services



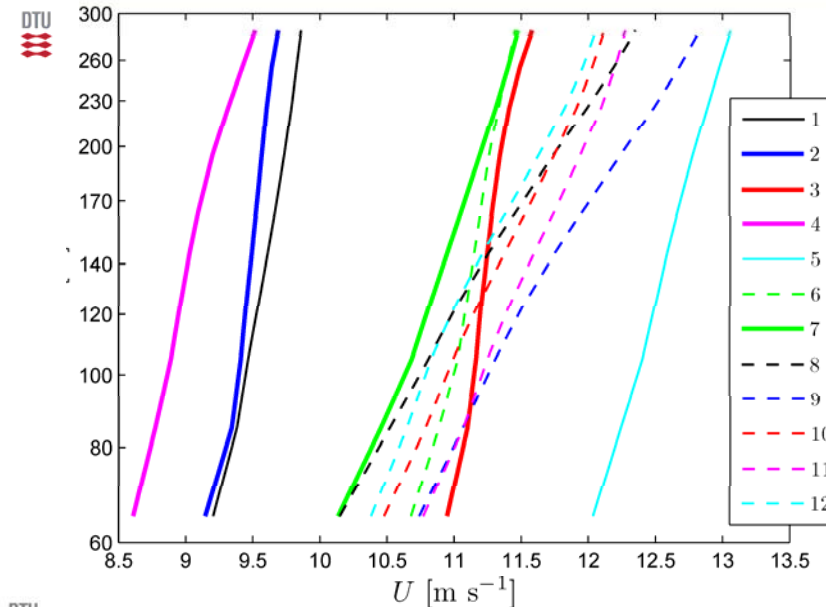
Data from DONG Energy



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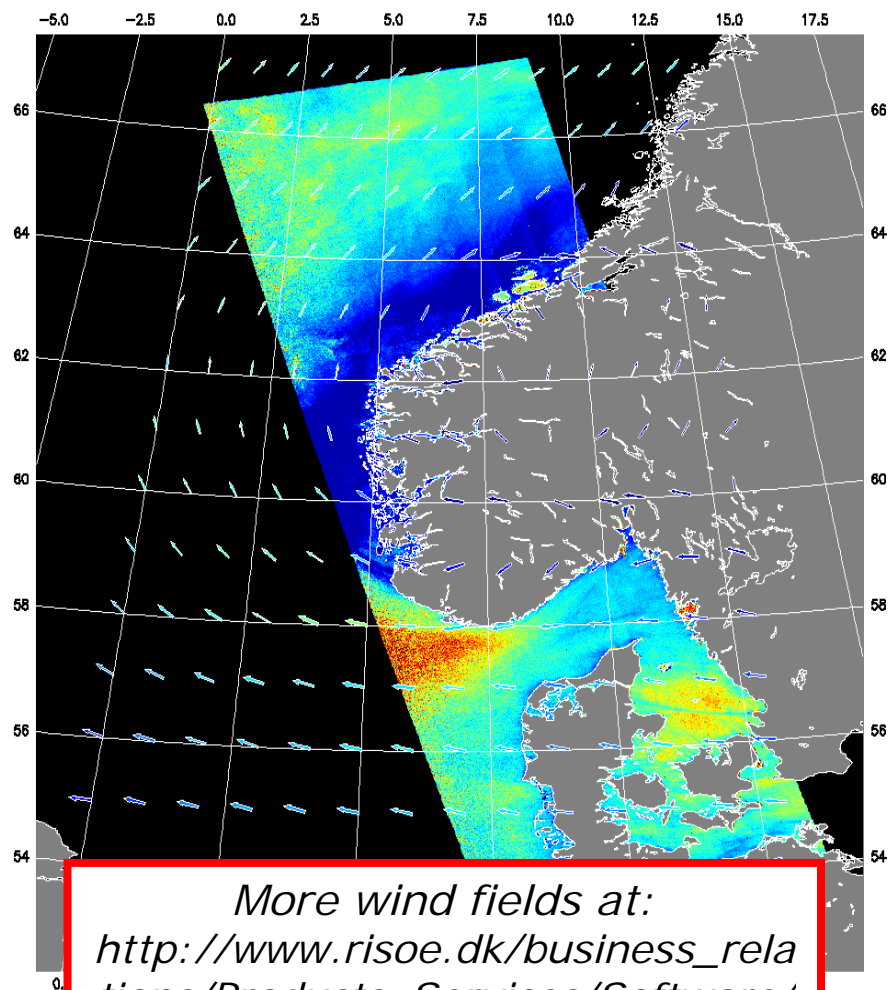


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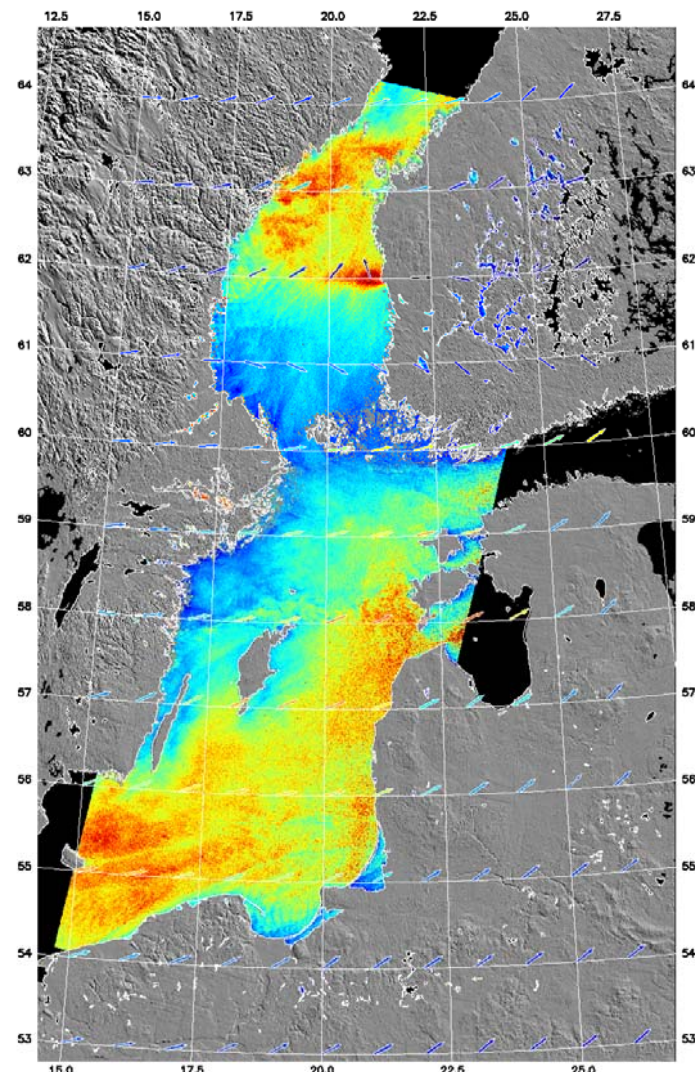
Envisat ASAR wind maps

_WSM_1PNPDK20060916_205641_000002442051_00172_23773_5546.N1 with NOGAPS Wind Directi

ASA_WSM_1PNPDE20090928_090650_000001902082_00494_39626_3423.N1 with NOGAPS Wind Directions



More wind fields at:
http://www.risoe.dk/business_relations/Products_Services/Software/VEA_windmaps.aspx



Wind Speed (m/s)

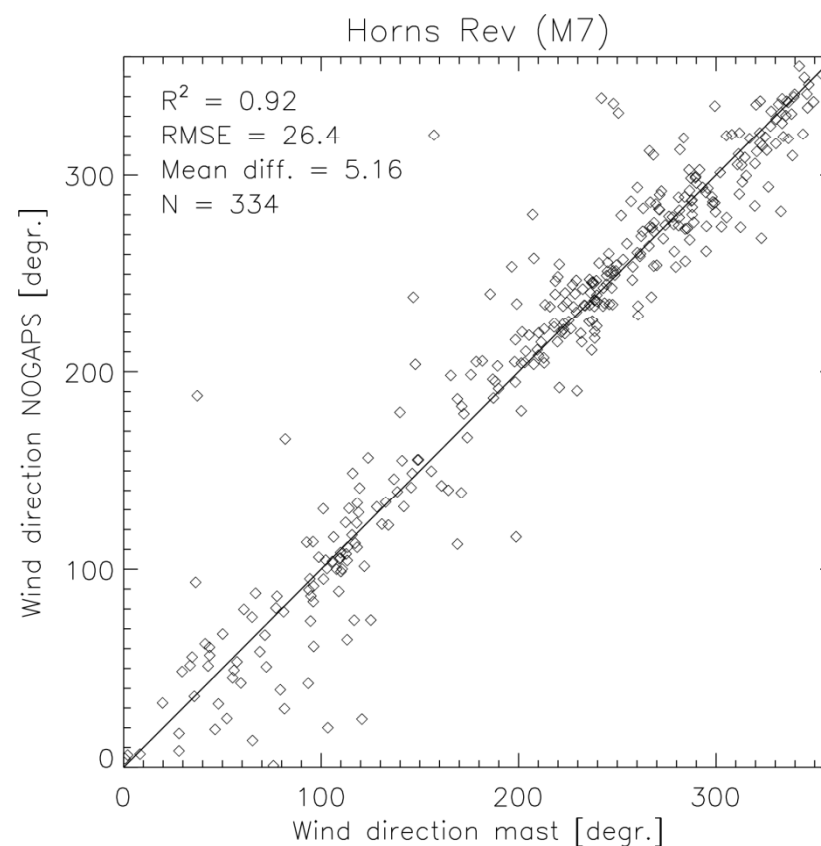
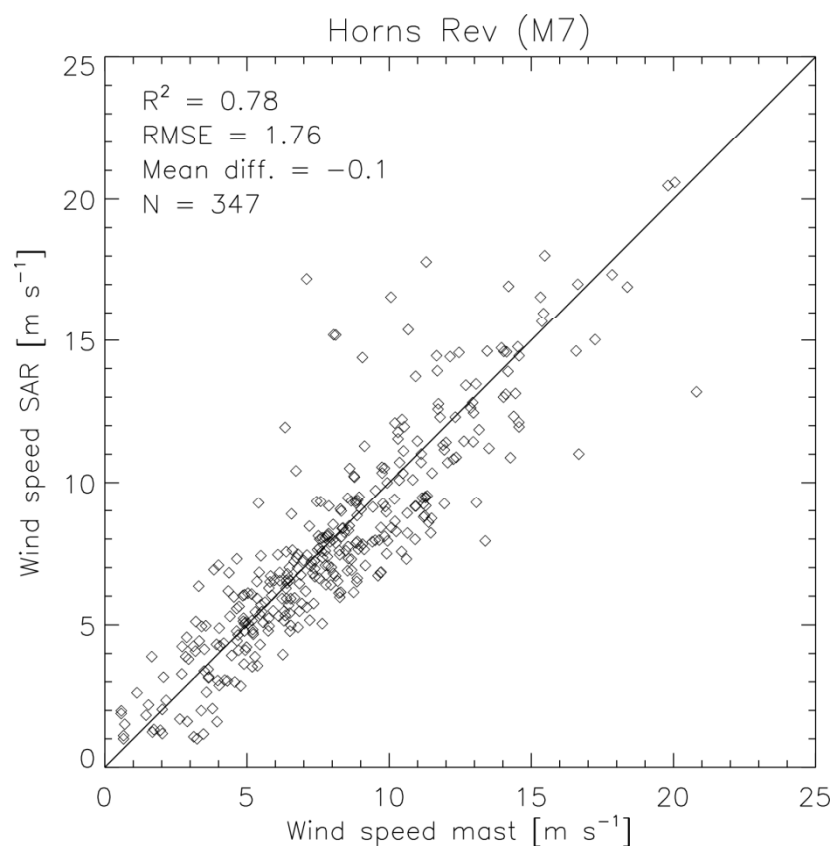
Wind Speed (knots)

Wind resource mapping from Envisat ASAR



- Envisat ASAR since 2006
- Validation against:
 - *Three masts*

Horns Rev offshore station: Wind speed and direction

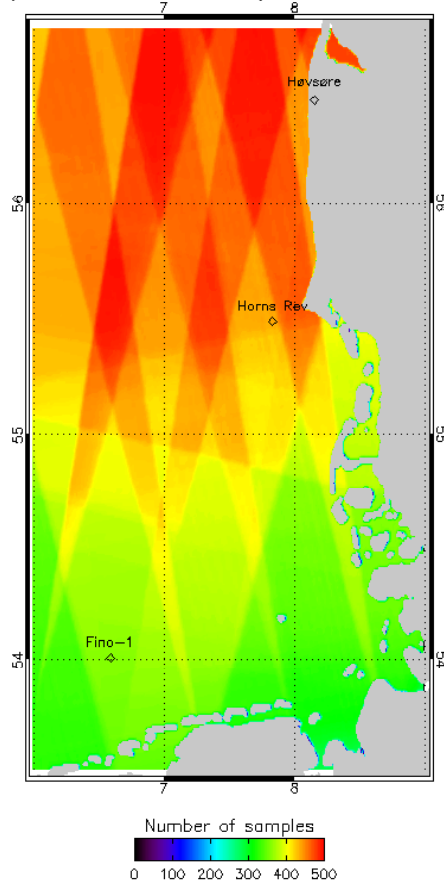


Hypothesis: SAR wind fields can be used
accordingly to represent individual wind situations

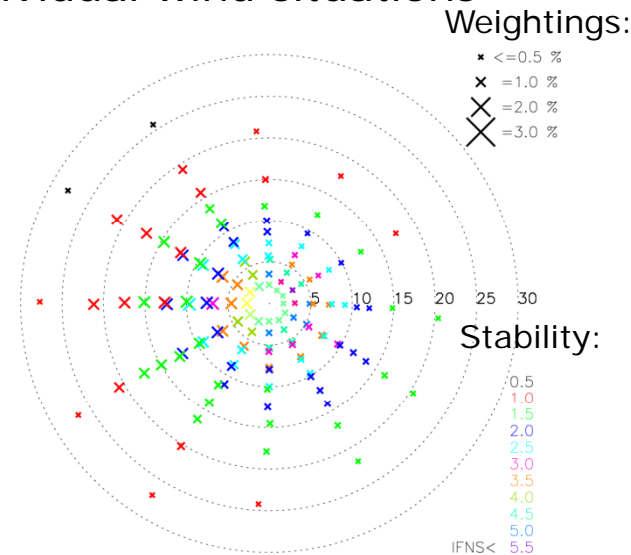
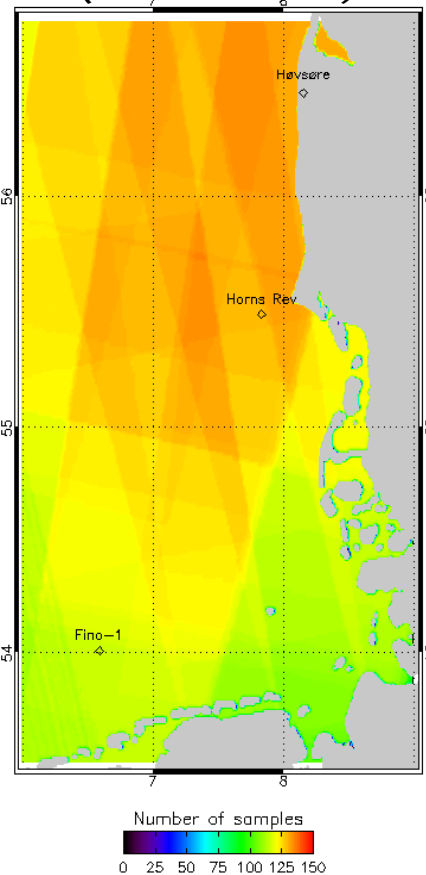


Number of wind maps

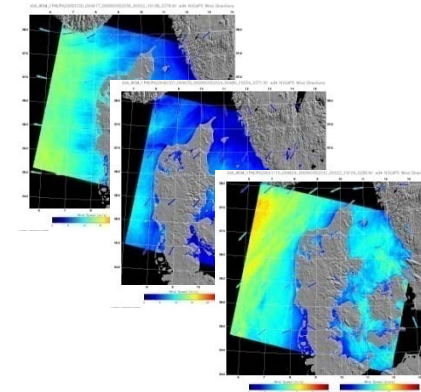
*Risø DTU's full archive
(627 scenes)*



*Wind class selection
(135 classes)*



*Wind class definition
from NCEP/NCAR re-analysis data*

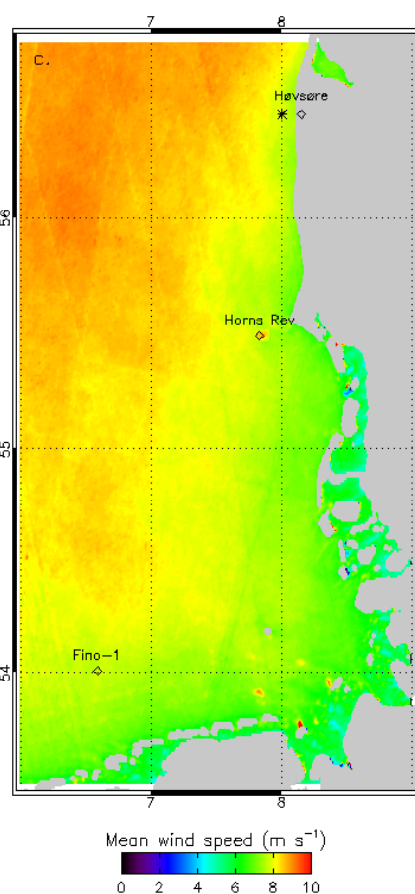
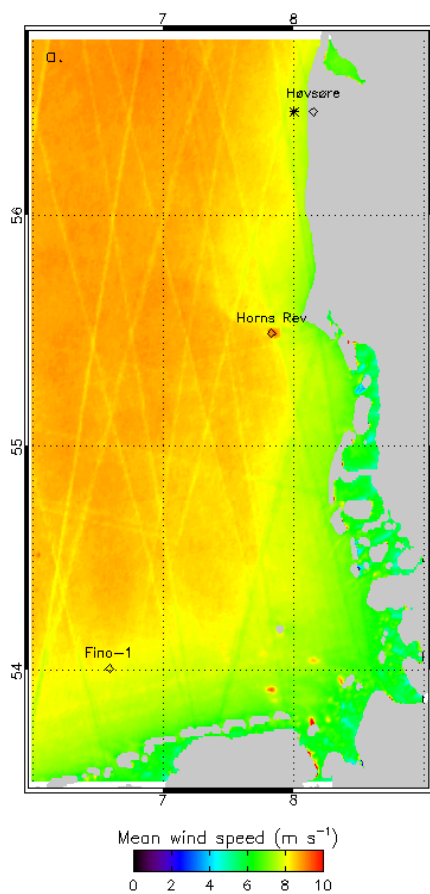


Population of each wind class

Mean wind speed

(627 scenes):

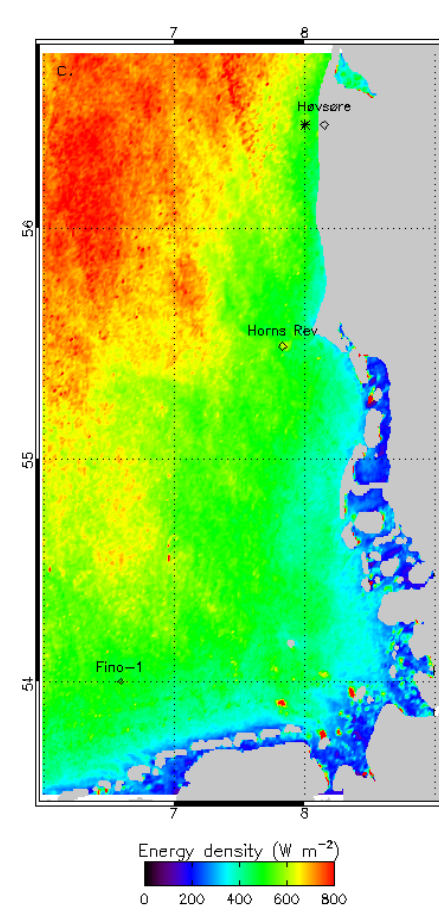
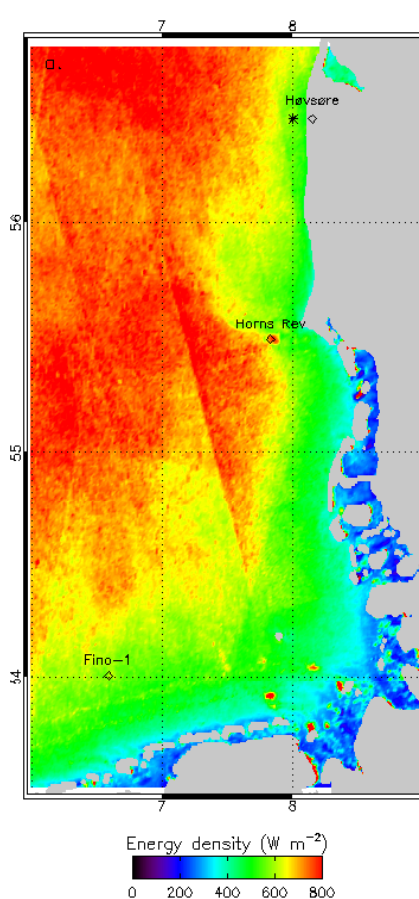
(135 classes):



Energy density

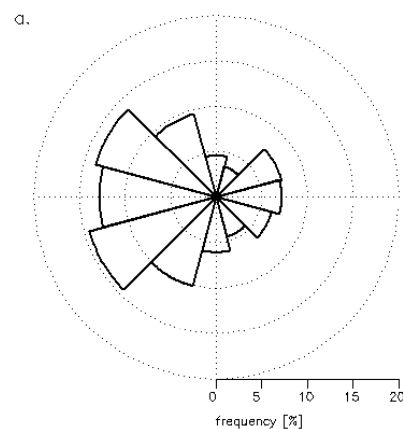
(627 scenes):

(135 classes):

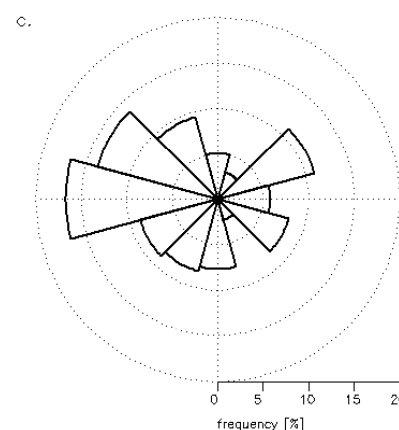


Høvsøre coastal station: Wind resources (2005-08)

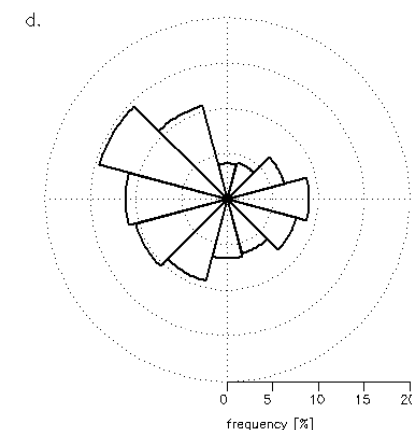
	N	U (m s^{-1})	U -deviation (%)	A (m s^{-1})	A -deviation (%)	k	k -deviation (%)	E (W m^{-2})	E -deviation (%)
SAR, full data set	444	7.9	0.9	8.9	0.8	2.1	-1.0	551	3.6
SAR, wind class selection	128	7.8	0.6	8.9	0.6	2.1	0.0	542	1.8
Meteorological data	204 041	7.8	-	8.8	-	2.1	-	532	-



SAR, full data set



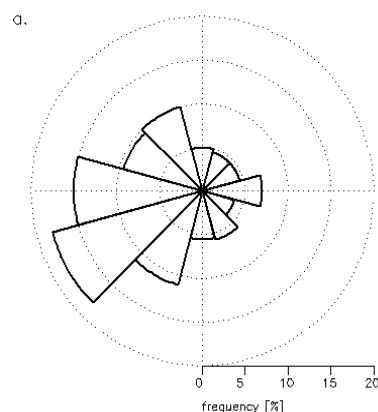
SAR, wind class selection



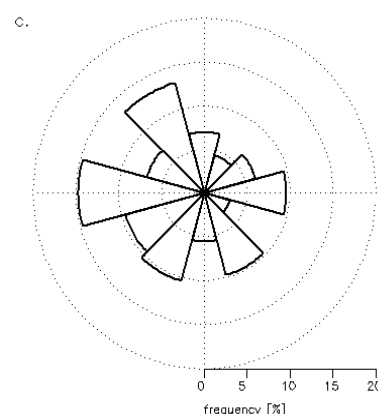
Meteorological data

Fino-1 offshore station: Wind resources (2005-08)

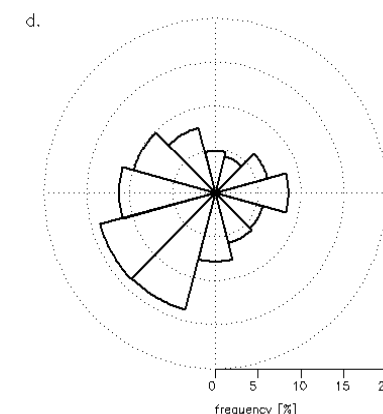
	N	U (m s^{-1})	U -deviation (%)	A (m s^{-1})	A -deviation (%)	k	k -deviation (%)	E (W m^{-2})	E -deviation (%)
SAR, full data set	359	8.1	-0.1	9.2	-0.4	2.1	-5.1	584	4.1
SAR, wind class selection	116	8.0	-2.0	9.0	-2.4	2.1	-5.1	550	-1.9
Meteorological data	192 479	8.1	-	9.2	-	2.3	-	561	-



SAR, full data set



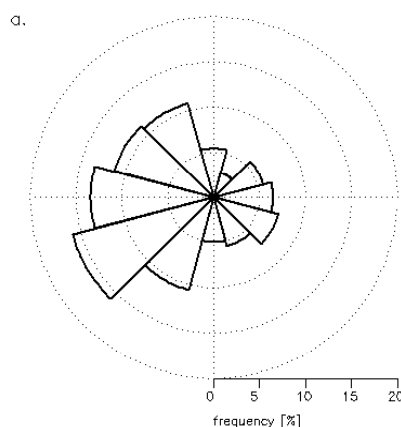
SAR, wind class selection



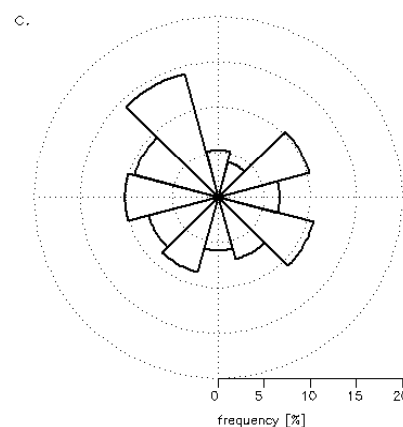
Meteorological data

Horns Rev offshore station: Wind resources (2005-08)

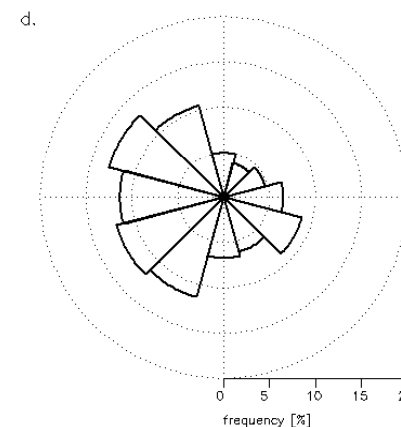
	N	U (m s^{-1})	U -deviation (%)	A (m s^{-1})	A -deviation (%)	k	k -deviation (%)	E (W m^{-2})	E -deviation (%)
SAR, full data set	464	7.7	-0.8	8.7	-0.9	2.1	-3.6	504	0.9
SAR, wind class selection	127	7.5	-4.1	8.4	-4.3	2.1	-5.9	465	-6.9
Meteorological data	200 086	7.8	-	8.8	-	2.2	-	499	-



SAR, full data set



SAR, wind class selection



Meteorological data

Results summary for the wind class method

	Mean Error	Mean Absolute Error
$U \text{ (m s}^{-1}\text{)}$	-1.8	2.2
$A \text{ (m s}^{-1}\text{)}$	-2.0	2.4
k	-3.7	3.7
$E \text{ (W m}^{-2}\text{)}$	-2.3	3.5

- Good overall agreement with mast observations on the wind resource
 - *within $\pm 5\%$ for the mean wind speed and Weibull A*
 - *within $\pm 7\%$ for the power density and Weibull k*
- The accuracy on wind resource assessment from mesoscale modeling is typically 10-15%

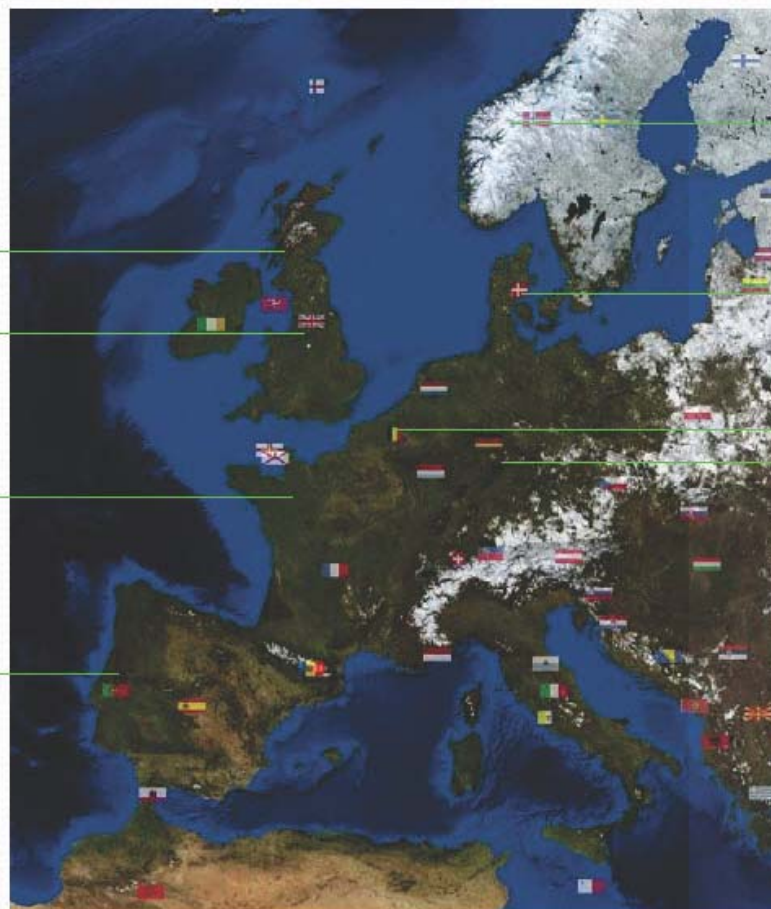
Norsewind consortium

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University;
Nautilus ; SE

Garrad
Hassan;

CLS

LNEG



Kjeller
Vindteknikk;
Statoil

DTU; DTU
RISOE;
DONG

3E

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IWES

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